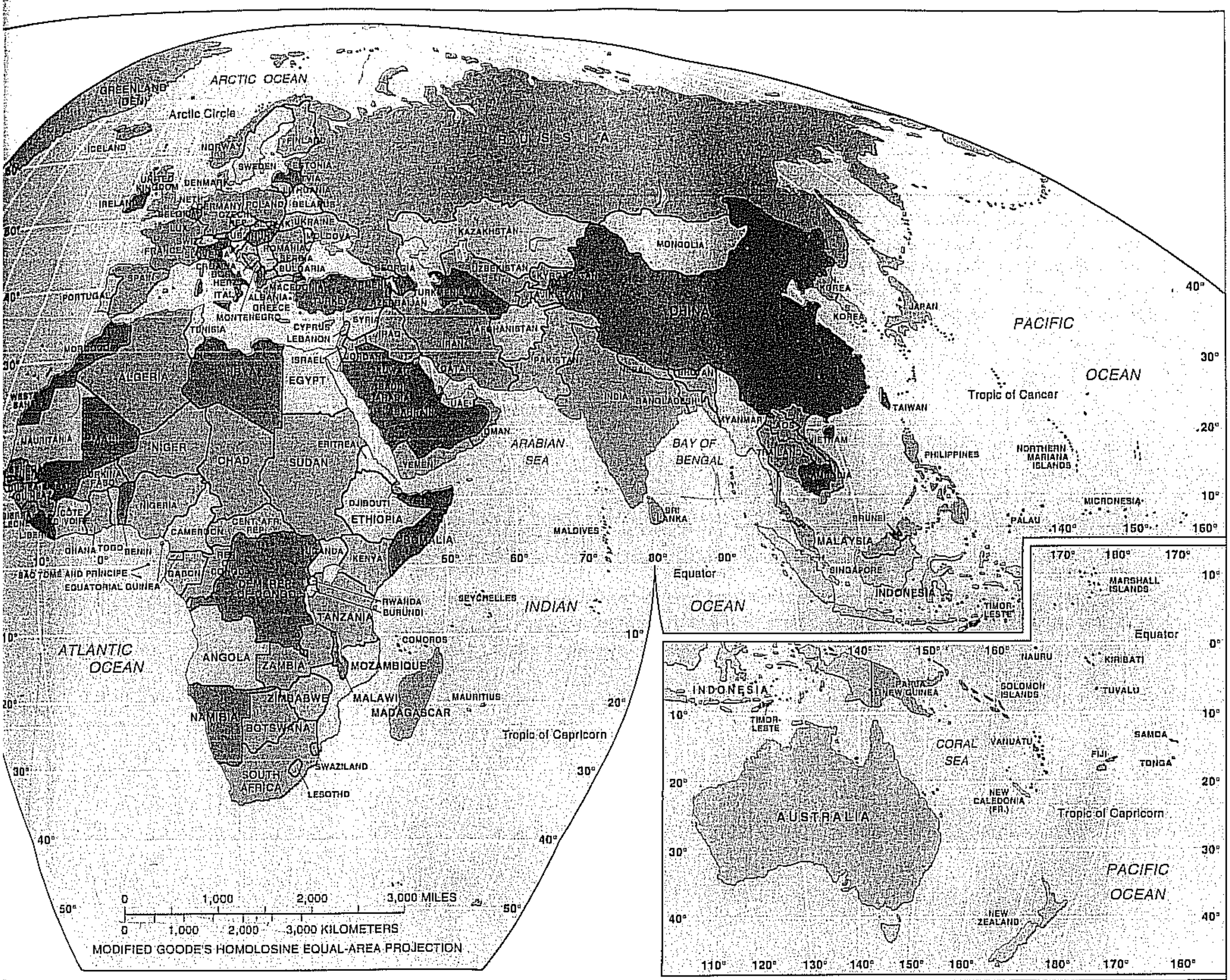


Maps

A map serves two purposes: It is a tool for storing reference material and a tool for communicating geographic information. As a reference source, a map helps us to find the shortest route between two places and to avoid getting lost along the way. We consult maps to learn where in the world something is found, especially in relation to a place we know, such as a town, body of water, or highway. The maps in an atlas or a road map are especially useful for this purpose.

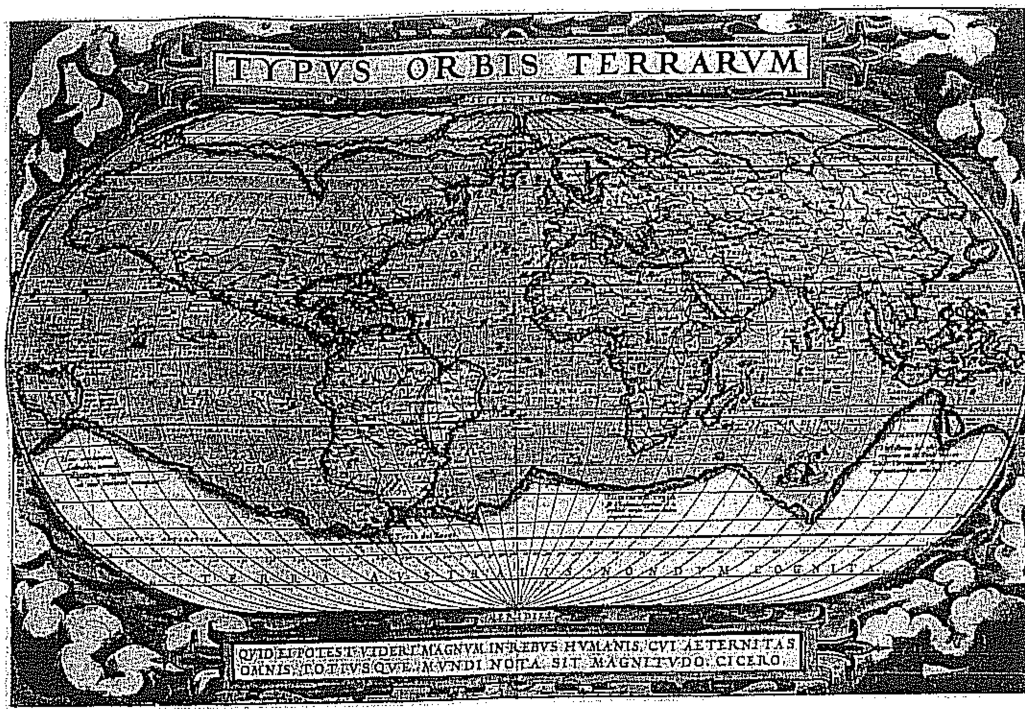
As a communications tool, a map is often the best means for depicting the distribution of human activities or physical features, as well as for thinking about reasons underlying a distribution. A series of maps of the same area over several years can reveal dynamic processes at work, such as human migration or spread of a disease. Patterns on maps may suggest interactions among different features of Earth. Placing information on a map is a principal way that geographers share data or results of scientific analysis.

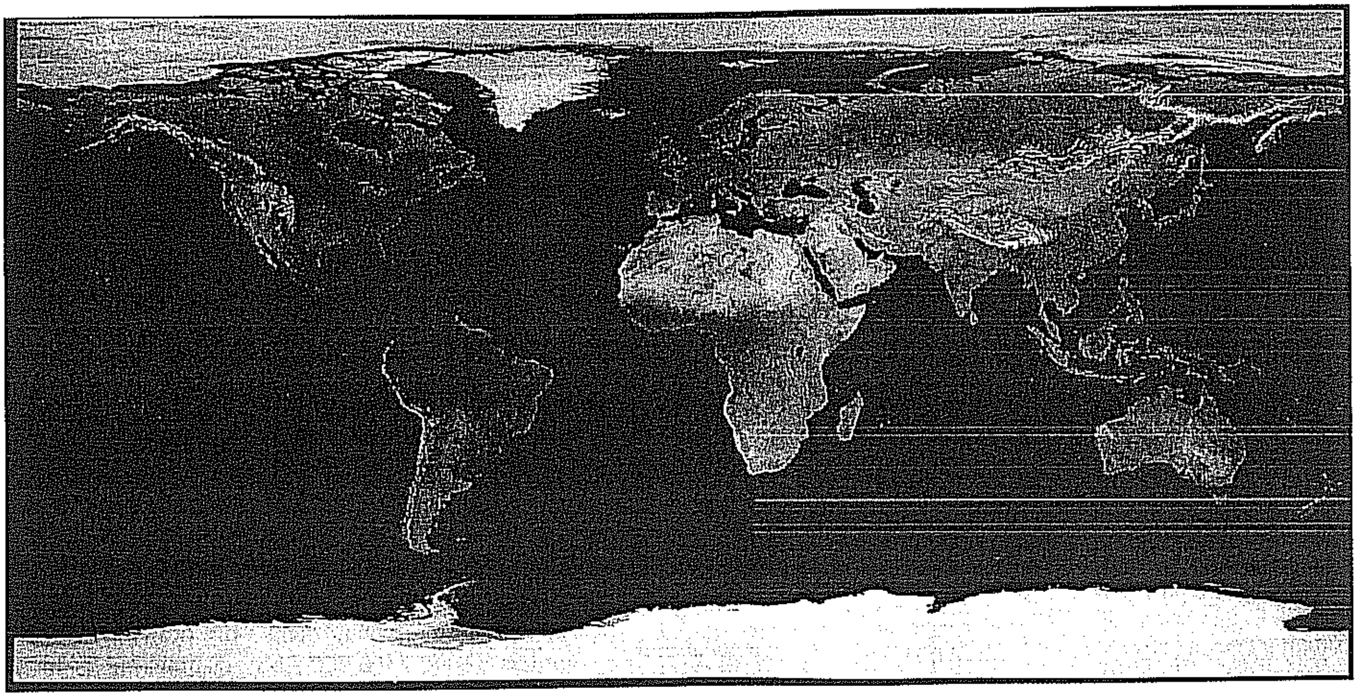
Early Mapmaking

The earliest surviving maps were drawn by Babylonians on clay tablets about 2300 B.C., but mapmaking is undoubtedly even older. From the earliest human occupancy of Earth, people have been creating maps to assist with navigation. Mediterranean sailors and traders made maps of rock formations, islands, and ocean currents as early as 800 B.C. Miletus, a port in present-day Turkey, became a center for geographic thought and mapmaking in the ancient world. Thales (624?–546? B.C.) applied principles of geometry to measuring land area. His student, Anaximander (610–546? B.C.), made a world map based on information from sailors, though he portrayed Earth's shape as a cylinder. Hecateus may have produced the first geography book around 500 B.C.

Aristotle (384–322 B.C.) was the first to demonstrate that Earth was spherical. He observed that matter falls together toward a common center, that Earth's shadow on the Moon is circular during an eclipse, and that the visible groups of stars change as one

(Top) Map of the world made in 1571 by Flemish cartographer Abraham Ortelius (1527–1598). (Bottom) Compare the accuracy of the coastlines on Ortelius's map with the recent image of the world based on satellite photographs. The composite image was assembled by the Geosphere Project of Santa Monica, California. Thousands of images were recorded over a ten-month period by satellites of the National Oceanographic and Atmospheric Administration. The images were then electronically assembled, much like a jigsaw puzzle.





travels north or south. Eratosthenes (276?–194? B.C.), the first person of record to use the word *geography*, also accepted that Earth was spherical and calculated its circumference within a remarkable 0.5 percent accuracy. He prepared one of the earliest maps of the known world, correctly dividing Earth into five climatic regions—a torrid zone across the middle, two frigid zones at the extreme north and south, and two temperate bands in between.

Two thousand years ago, the Roman Empire controlled an extensive area of the known world, including much of Europe, northern Africa, and western Asia. Taking advantage of information collected by merchants and soldiers who traveled through the Roman Empire, the Greek Ptolemy (A.D. 100?–170?) wrote an eight-volume *Guide to Geography*. He codified basic principles of mapmaking and prepared numerous maps, which were not improved upon for more than a thousand years. Ancient Greek and Roman maps were compiled in the *Barrington Atlas of the Greek and Roman World*. "We can't truly understand the Greeks and Romans without good maps that show us their world," explained *Barrington Atlas* editor Richard J. A. Talbert.

After Ptolemy, little progress in mapmaking or geographic thought was made in Europe for several hundred years. Maps became less mathematical and more fanciful, showing Earth as a flat disk surrounded by fierce animals and monsters. Geographic inquiry continued, though, outside of Europe. The oldest

Chinese geographical writing, from the fifth century B.C., describes the economic resources of the country's different provinces. Phei Hsiu (or Fei Xiu), the "father of Chinese cartography," produced an elaborate map of the country in A.D. 267. The Muslim geographer al-Idrisi (1100–1165?) prepared a world map and geography text in 1154, building on Ptolemy's long-neglected work. Ibn-Battutah (1304–1368?) wrote *Rihlah* ("Travels") based on three decades of journeys covering more than 120,000 kilometers (75,000 miles) through the Muslim world of northern Africa, southern Europe, and much of Asia.

A revival of geography and mapmaking occurred during the Age of Exploration and Discovery. Ptolemy's maps were rediscovered, and his writings were translated into European languages. Columbus, Magellan, and other explorers who sailed across the oceans in search of trade routes and resources required accurate maps to reach desired destinations without wrecking their ships. In turn, cartographers such as Gerardus Mercator (1512–1594) and Abraham Ortelius (1527–1598) took information collected by the explorers to create more accurate maps. By the seventeenth century, maps accurately displayed the outline of most continents and the positions of oceans. Bernhardus Varenius (1622–1650) produced *Geographia Generalis*, which stood for more than a century as the standard treatise on systematic geography.

Map Scale

The first decision a cartographer faces is how much of Earth's surface to depict on the map. Is it necessary to show the entire globe, or just one continent, or a country, or a city? To make a scale model of the entire world, many details must be omitted because there simply is not enough space. Conversely, if a map shows only a small portion of Earth's surface, such as a street map of a city, it can provide a wealth of detail about a particular place.

The level of detail and the amount of area covered on a map depend on its scale. When specifically applied to a map, **scale** refers to the relationship of a feature's size on a map to its actual size on Earth. Map scale is presented in three ways: a fraction (1/24,000) or ratio (1:24,000), a written statement ("1 inch equals 1 mile"), or a graphic bar scale (Figure 1–3). Maps often display scale in more than one of these three ways.

A fractional scale shows the numerical ratio between distances on the map and Earth's surface. A scale of 1:24,000 or 1/24,000 means that one unit (inch, centimeter, foot, finger length) on the map represents 24,000 of the same unit (inch, centimeter, foot, finger length) on the ground. The unit chosen for distance can be anything, as long as the units of measure on both the map and the ground are the same. The 1 on the left side of the ratio always refers to a unit of distance *on the map*, and the number on the right always refers to the *same unit* of distance *on Earth's surface.*

The written scale describes this relation between map and Earth distances in words. For example, the statement "1 inch equals 1 mile" on a map means that one inch on the map represents one mile on Earth's surface. Again, the first number always refers to map distance, and the second to distance on Earth's surface.

A graphic scale usually consists of a bar line marked to show distance on Earth's surface. To use a bar line, first determine with a ruler the distance on the map in inches or centimeters. Then hold the ruler against the bar line and read the number on the bar line opposite the map distance on the ruler. The number on the bar line is the equivalent distance on Earth's surface.

The appropriate scale for a map depends on the information being portrayed. A map of a downtown area, such as Figure 1–3 upper right, has a scale of 1:10,000, whereas the map of Washington State (Figure 1–3 upper left) has a scale of 1:10,000,000, and the map of the entire world, such as that shown in Figure 1–2, has a scale of about 1:100,000,000. One inch represents about 1/6 mile on the downtown Seattle map and about 1,700 miles on the world map. At the scale of a small portion of Earth's surface, such as a downtown area, a map provides a wealth of details about the place. At the scale of the entire globe, a map must omit many details because of lack of space, but it can effectively communicate processes and trends that affect everyone.

Projection

Earth is very nearly a sphere and therefore accurately represented in the form of a globe. However, a globe is an extremely limited tool with which to communicate information about Earth's surface. A small globe does not have enough space to display detailed information, whereas a large globe is too bulky and cumbersome to use. And a globe is difficult to write on, photocopy, display on a computer screen, or carry in the glove box of a car. Consequently, most maps—including those in this book—are flat. Three-dimensional maps can be made but are expensive and difficult to reproduce.

Earth's spherical shape poses a challenge for cartographers because drawing Earth on a flat piece of paper unavoidably produces some distortion. Cartographers have invented hundreds of clever methods of producing flat maps, but none have produced perfect results. The scientific method of transferring locations on Earth's surface to a flat map is called **projection.**

The problem of distortion is especially severe for maps depicting the entire world. Four types of distortion can result:

1. The *shape* of an area can be distorted, so that it appears more elongated or squat than in reality.
2. The *distance* between two points may become increased or decreased.
3. The *relative size* of different areas may be altered, so that one area may appear larger than another on a map but is in reality smaller.
4. The *direction* from one place to another can be distorted.

Most of the world maps in this book, such as Figure 1–2, are *equal area projections*. The primary benefit of this type of projection is that the relative sizes of the landmasses on the map are the same as in reality. The projection minimizes distortion in the shapes of most landmasses, although areas toward the North and South poles—such as Greenland and Australia—become more distorted. These areas are sparsely inhabited, so distorting their shapes usually is not important.

To largely preserve the size and shape of landmasses, however, the projection in Figure 1–2 forces other distortions:

- The Eastern and Western hemispheres are separated into two pieces, a characteristic known as interruption.